What is claimed is:

1. A method for reducing speckle of a laser beam comprising the step of shifting a phase of a first portion of the laser beam relative to a second portion of the laser beam, such that a spatial coherence of the laser beam is disrupted while a temporal coherence of the laser beam is maintained substantially unchanged.

2. A method according to claim 1 wherein the step of shifting a phase of a first portion of the laser beam comprises transmitting the first portion of the laser beam through a region of a holographic plate.

3. A method according to claim 1 wherein the step of shifting a phase of a first portion of the laser beam comprises transmitting the laser beam through a DUV-VUV transparent substrate bearing a phase shift optical coating over a first substrate region through which the first beam portion is transmitted.

4. A method according to claim 3 wherein the step of shifting a phase of a first portion of the laser beam comprises transmitting the laser beam through a DUV-VUV transparent substrate bearing a periodic phase shift optical coating, the periodic phase shift optical coating corresponding to a desired minimum number of spatially coherent cells of the laser beam.

5. A method according to claim 1 wherein the step of shifting a phase of a first portion of the laser beam comprises reflecting the laser beam from a DUV-VUV reflective substrate bearing a phase shift optical coating over a first substrate region from which the first beam portion is reflected.

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medium having an index of refraction producing a desired minimum number of spatially coherent cells of the laser beam.

12. An apparatus for reducing speckle of a laser beam comprising a DUV-VUV transparent substrate bearing periodic phase shift optical coating over a first region, the phase shift optical coating causing a phase shift of light transmitted through the first region relative to light transmitted outside of the first region, such that the phase shift generates a desired minimum number of spatially coherent cells in the laser beam.

13. An apparatus according to claim 12 wherein the transparent substrate comprises one of fused silica, quartz glass, calcium fluoride, magnesium fluoride, lithium fluoride, and barium fluoride.

14. An apparatus according to claim 12, wherein the optical coating comprises at least one of silicon dioxide and silicon nitride.

15. An apparatus according to Claim 12, further comprising a fle eye lens.

16. An apparatus for reducing speckle of a laser beam comprising a DUV-VUV reflective substrate bearing a periodic phase shift optical coating over a first region, the optical coating causing a phase shift of light reflected by the first region relative to light reflected outside of the first region, such that the phase shift generates a desired minimum number of spatially coherent cells in the laser beam.

8 ~~17~~. An apparatus according to claim 7 ~~16~~, wherein the reflective substrate comprises a shiny metallic layer.

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18. An apparatus according to claim 1 ~~16~~ wherein the phase shift optical coating comprises at least one of silicon dioxide and silicon nitride.

10 ~~19~~. An apparatus according to claim 1 ~~16~~ wherein the coated reflective substrate is an outcoupling mirror of a laser resonator.

11 ~~20~~. An apparatus according to Claim 10 ~~19~~, further comprising a fly eye lens after the reflective substrate.

12 ~~21~~. An apparatus according to Claim 1 ~~16~~, further comprising a fly eye lens after the reflective substrate.

13 ~~22~~. An apparatus according to claim 1 ~~16~~ wherein the coated reflective substrate is positioned outside of a laser resonator.

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23. An apparatus for reducing speckle of a laser beam comprising a DUV-VUV transparent substrate bearing a rough surface having a standard deviation in surface height and a correlation length, the rough surface causing scattering of light transmitted through the substrate to generate a desired minimum number of spatially coherent cells in the laser beam.

24. An apparatus according to claim 23 wherein the transparent substrate comprises one of fused silica, quartz glass, calcium fluoride, magnesium fluoride, lithium fluoride, and barium fluoride.

14 ~~25~~. An apparatus according to claim 14 ~~23~~ wherein the rough surface is a ground surface.

17 ~~26~~. An apparatus according to claim 14 ~~25~~ wherein the rough surface is overpolished to adjust the standard deviation in surface height.

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~~27~~ 18. An apparatus according to claim ~~23~~ 14 further comprising a matching medium in contact with the rough layer, a refractive index of the matching medium adjusting spatial coherence of the laser beam transmitted through the substrate.

~~28~~ 19. An apparatus according to claim ~~27~~ 18 wherein the matching medium is a solid.

~~29~~ 20. An apparatus according to claim ~~27~~ 18 wherein the matching medium is a liquid.

~~30~~ 21. An apparatus according to claim ~~23~~ 14 wherein the substrate bears an anti-reflective coating.

~~31~~ 22. An apparatus according to claim ~~23~~ 14, wherein said substrate is an outputcoupler of the laser system that produces the laser beam.

~~32~~ 23. An apparatus according to claim ~~31~~ 22, further comprising a fly eye lens after the substrate.

~~33~~ 24. An apparatus according to claim ~~23~~ 14, further comprising a fly eye lens after the substrate.

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34. An apparatus for reducing speckle of a laser beam comprising a DUV-VUV reflective substrate bearing a rough surface having a standard deviation in surface height and a correlation length, the rough surface causing scattering of light reflected by the substrate to generate a desired minimum number of spatially coherent cells in the laser beam.

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~~35~~. An apparatus according to claim ~~34~~ 25 wherein the reflective substrate comprises a shiny metallic layer.

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~~36~~. An apparatus according to claim ~~34~~ 25 wherein the rough surface is a ground surface.

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~~37~~. An apparatus according to claim ~~36~~ 27 wherein the rough surface is overpolished to adjust the standard deviation in surface height.

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~~38~~. An apparatus according to claim ~~34~~ 25 wherein the reflective substrate is an outcoupling mirror of a laser resonator.

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~~39~~. An apparatus according to claim ~~38~~ 29, further comprising a fly eye lens after the substrate outcoupling mirror.

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~~40~~. An apparatus according to claim ~~34~~ 25 wherein the reflective substrate is positioned outside of a laser resonator.

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~~41~~. An apparatus according to claim ~~40~~ 31, further comprising a fly eye lens after the substrate.

42. A lithography apparatus comprising:

an excimer laser configured to generate a laser beam having a spatial coherence, the excimer laser including a resonator and an outcoupling mirror;

a line narrowing apparatus located within the resonator for improving the spectral purity of the laser beam;

optics configured to deliver the laser beam to a semiconductor workpiece; and

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6. A method according to claim 5 wherein the step of shifting a phase of a first portion of the laser beam comprises reflecting the laser beam from a DUV-VUV reflective substrate bearing a periodic phase shift optical coating, the periodic phase shift optical coating corresponding to a desired minimum number of spatially coherent cells of the laser beam.

7. A method for reducing speckle of a laser beam comprising the step of scattering a first portion of the laser beam relative to a second portion of the laser beam, such that a spatial coherence of the laser beam is disrupted while a temporal coherence of the laser beam is maintained substantially unchanged.

8. A method according to claim 7 wherein the step of scattering a first portion of the laser beam comprises transmitting the laser beam through a DUV-VUV transparent substrate having a rough surface, a correlation length and a structure height of the rough surface corresponding to a desired minimum number of spatially coherent cells of the laser beam.

9. A method according to claim 8 further comprising the step of transmitting the laser beam directly from the rough surface to a matching medium having an index of refraction producing a desired minimum number of spatially coherent cells of the laser beam.

10. A method according to claim 7 wherein the step of scattering a first portion of the laser beam comprises reflecting the laser beam off of a DUV-VUV reflective substrate having a rough surface, a correlation length and a structure height of the rough surface corresponding to a desired minimum number of spatially coherent cells of the laser beam.

11. A method according to claim 10 further comprising the step of reflecting the laser beam directly from the rough surface to a matching

an anti-speckle device located in the path of the laser beam before the delivery optics for disrupting the spatial coherence of the laser beam.

43. An apparatus according to claim 42 wherein the anti-speckle device comprises a DUV-VUV transparent substrate bearing a periodic phase shift optical coating over a first region, the phase shift optical coating causing a phase shift of the laser beam transmitted through the first region relative to the laser beam transmitted outside of the first region.

44. An apparatus according to claim 43 wherein the laser beam generated by the laser has a spectral purity of 100 pm or less upon reaching the workpiece.

45. An apparatus according to claim 43 wherein the laser beam generated by the laser has a spectral purity of 10 pm or less upon reaching the workpiece.

46. An apparatus according to claim 43 wherein the laser beam generated by the laser has a spectral purity of 1 pm or less upon reaching the workpiece.

47. An apparatus according to claim 42 wherein the anti-speckle apparatus comprises a DUV-VUV reflective substrate bearing a periodic phase shift optical coating over a first region, the optical coating causing a phase shift of the laser beam reflected by the first region relative to the laser beam reflected outside of the first region.

48. An apparatus according to claim 47 wherein the laser beam generated by the laser has a spectral purity of 100 pm or less upon reaching the workpiece.

49. An apparatus according to claim 47 wherein the laser beam generated by the laser has a spectral purity of 10 pm or less upon reaching the workpiece.

50. An apparatus according to claim 47 wherein the laser beam generated by the laser has a spectral purity of 1 pm or less upon reaching the workpiece.

51. An apparatus according to claim 47 wherein the anti-speckle device also comprises the outcoupling mirror.

52. An apparatus according to claim 51 further comprising a fly eye lens after the anti-speckle device.

53. An apparatus according to claim 47, further comprising a fly eye lens after the anti-speckle device.

54. An apparatus according to claim 42 wherein the anti-speckle apparatus comprises a DUV-VUV transparent substrate bearing a rough surface having a standard deviation in surface height and a correlation length, the rough surface causing scattering of the laser beam transmitted through the substrate.

55. An apparatus according to claim 54 wherein the laser beam generated by the laser has a spectral purity of 100 pm or less upon reaching the workpiece.

56. An apparatus according to claim 54 wherein the laser beam generated by the laser has a spectral purity of 10 pm or less upon reaching the workpiece.

57. An apparatus according to claim 54 wherein the laser beam generated by the laser has a spectral purity of 1 pm or less upon reaching the workpiece.

58. An apparatus according to claim 54 further comprising a matching medium in contact with the rough layer, a refractive index of the matching medium adjusting spatial coherence of the laser beam transmitted through the substrate.

59. An apparatus according to claim 58 wherein the matching medium is a solid.

60. An apparatus according to claim 58 wherein the matching medium is a liquid.

61. An apparatus according to claim 54 wherein the anti-speckle device also comprises the outcoupling mirror.

62. An apparatus according to claim 61 further comprising a fly eye lens after the anti-speckle device.

63. An apparatus according to claim 54 further comprising a fly eye lens after the anti-speckle device.

64. An apparatus according to claim 42 wherein the anti-speckle device comprises a DUV-VUV reflective substrate bearing a rough surface having a standard deviation in surface height and a correlation length, the rough surface causing scattering of the laser beam light reflected by the substrate.

65. An apparatus according to claim 64 wherein the laser beam generated by the laser has a spectral purity of 100 pm or less upon reaching the workpiece.

66. An apparatus according to claim 64 herein the laser beam generated by the laser has a spectral purity of 10 pm or less upon reaching the workpiece.

67. An apparatus according to claim 64 wherein the laser beam generated by the laser has a spectral purity of 1 pm or less upon reaching the workpiece.

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68. An apparatus according to claim 64 wherein the rough surface is a ground surface.

69. An apparatus according to claim 64 wherein the reflective substrate also comprises the outcoupling mirror.

70. An apparatus according to claim 69 further comprising a fly eye lens after the anti-speckle device.

71. An apparatus according to claim 64 further comprising a fly eye lens after the anti-speckle device.

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